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CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of German application DE 101 05 978.7, filed with the German Patent Office on February 9, 2001.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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MULTIBEAM SCANNING DEVICE FOR SCANNING A PHOTOSENSITIVE MATERIAL WITH A MULTI-SPOT ARRAY, AND METHOD OF CORRECTING THE POSITION OF IMAGE POINTS OF THE MULTI-SPOT ARRAY

The invention relates to the field of electronic reproduction technology, in particular to the laser engraving of printing plates but also to the laser exposure of film with a multi-spot array. In particular, the invention relates to a multibeam scanning device for scanning a photosensitive material with a multi-spot array, comprising a plurality of fiber laser fiber exits, which are in each case inserted detachably into a holder in a mount of the multibeam scanning device and secondly to a method of correcting the position of image points of a multi-spot array which is produced by imaging a plurality of fiber laser fiber exits on a photosensitive material, moved in relation thereto, and by interrupting, deflecting and/or modulating the intensity of laser beams emerging from the fiber exits.

In the laser engraving of flexo printing plates in a laser exposer, the printing plate to be processed is clamped onto a rotating drum and, in order to increase the processing speed, is scanned simultaneously with a plurality of laser beams, in order to remove the laser-sensitive layer in the subsequent printing areas of the printing plate point by point in accordance with a pre-defined pattern. In order to provide the power necessary for the laser engraving the multi-beam scanning devices or laser processing heads of the laser exposer used are equipped with fiber lasers, whose fiber exits are arranged beside one another and are aligned with the drum or printing plate in such a way that the latter is scanned

with a linear multi-spot array. The multibeam scanning devices or laser processing heads further comprise an optical system for imaging the fiber exits and for focusing the laser beams on the surface of the printing plate, and also devices for the selective interruption, deflection and/or intensity modulation of the individual laser beam. Such a multibeam scanning device is described in the as yet unpublished German patent application DE 100 24 456.4 by the applicant.

In order to mount fiber exits on a laser processing head or the like, it is further known to insert the fiber exits, fitted with micro lenses or collimator lenses, into precision holes or V-shaped accommodation grooves of a mount in such a way that they have the desired alignment. Because of fabrication tolerances during the production of the fiber exits, during the fitting with the lenses and during the production of the mount or the fiber exit holders, however, in practice directional deviations of the laser beams from their envisaged optical axis occur, which manifest themselves in the form of position errors, that is to say deflections of individual image points of the multi-spot array in any desired direction from their intended position. Because of their repeated occurrence during the scanning, these position errors during the processing of printing plates or during the recording of an image on a film lead to disruptive patterns and therefore to an impairment of quality.

The greatest position deviations are customarily caused by so-called pointing errors of the fiber exit, that is to say the angular deviation of an emitted laser beam in relation to a cylinder axis of a capillary tube used for mounting the fiber exit and the collimator lens.

From a magazine article with the title "180-mega-pixel per second optical image recording" by Bernard M. Rosenheck, SPIE Vol. 299 Advances in Laser Scanning Technology (1981), it is already known per se to perform electronic adjustment of image points of a two-dimensional multi-spot array by deflecting laser beams by means of an acousto-optical modulator. In addition, electronic displacement of image points by applying voltage signals with a time delay to acousto-optical modulators is known per se in laser exposers.

On this basis, the invention is based on the object of providing a multibeam scanning device and a correction method of the type mentioned at the beginning with which multi-spot array may be produced with high precision, so that when the photosensitive material is used as printing original, no disruptive patterns are visible on the end product.

According to the invention, this object is achieved by the combinations of features specified in patent claims 1 and 12. Preferred refinements of the invention will be found in the subordinate claims 2 to 11 and 13 to 20.

The invention is based on the idea of providing, by means of a coincident angular alignment of all the image points of the multi-spot array in relation to their respective intended position, the precondition for an electronic adjustment by means of deflection and/or propagation-time delay of the laser beams, with which all the laser beams are shifted so far in the same direction, namely in the direction of their intended position, until their distance from this intended position is zero or virtually zero.

The use of complementary alignment devices on the fiber exits and the mounting of the multi-beam scanning device permit rapid mounting, during the assembly of the latter and during the replacement of a defective fiber exit, in the alignment required for the electronic adjustment.

In the simplest case, the complementary alignment devices of a fiber exit and the mounting can comprise a color marking printed or painted onto the fiber exit, which points in a specific direction, for example vertically upward and is aligned with a corresponding marking on the mount, as soon as the fiber exit has been inserted into the holder with the previously defined rotational angle. However, the alignment device of the fiber exit preferably comprises an element which projects radially beyond the fiber exit, can be brought into engagement with a form fit with a complementary element belonging to the mount when the fiber exit in the holder exhibits the previously defined rotational angle.

The more time-consuming determination of the pointing error of each fiber exit and the subsequent fixing of the alignment device in the correct rotational position on the fiber exit can be carried out at the manufacturer of the multibeam scanning device, where suitable adjustment devices are available. These preferably have a mount corresponding to the mount of the multibeam scanning device and having a fiber exit holder, into which the fiber exits are inserted one after another and rotated about their axis. When the laser is switched on, an image point produced on a position detector of the adjustment device describes a circular path, whose diameter is greater the greater the pointing error of the fiber exit. As soon as the image point exhibits a predefined angular alignment in relation to a coordinate zero point of

the position detector, the alignment device is fixed to the fiber exit in a fixed angular relationship, specifically in such a way that it points in the same direction in the case of all the adjusted fiber exits.

The electronic adjustment of each image point in order to reduce its distance from the respective intended position by means of deflecting the laser beam is preferably carried out with the aid of an acousto-optical modulator which is arranged in the beam path between the fiber exit and the photosensitive material and which, in many exposers, is already present and serves there to interrupt or deflect and/or modulate the intensity of the laser beam.

In addition, the reduction in the distance of an image point from its intended position by means of delaying the point of incidence of the laser beam can be carried out with the aid of the acousto-optical modulator, in that the voltage signals applied to the acousto-optical modulator in order to interrupt or deflect and/or modulate the intensity of the laser beams are supplied with a time delay which takes account of the distance of the respective image point from the intended position.

In order to correct pointing errors of the fiber exit, in principle one of the two aforementioned alternatives, namely deflection of the laser beams or delay of the point of incidence of the laser beams, would be sufficient if the rotational angle of the fiber exit in the mount is defined in such a way that the image points are shifted precisely in the direction of their intended position by the deflection or by the time delay.

However, since not only the fiber exits themselves but also the mount and the fiber exit holders belonging to the mount are affected by fabrication tolerances, a further preferred refinement of the invention envisages reducing the distances between the image points and their intended position both by means of deflection and also by means of a time delay of the laser beams, the two measures being carried out alternately in order to effect an iterative approach to the respective intended position. This is assisted by the fact that in the case of the drum exposers used for film exposure or laser engraving, an image point of the multi-spot array is shifted by the deflection or by the time delay of the laser beam in the acousto-optical modulator in one of two directions that are substantially perpendicular to each other, so that the approach to the intended position can be carried out in staged steps which become smaller.

In the following text, the invention will be explained in more detail using some exemplary embodiments illustrated in the drawing, in which:

fig. 1 shows a perspective view of a device according to the invention for the laser engraving of flexo printing plates on a rotating drum with a linear multi-spot array;

fig. 2 shows a schematic representation of the beam path in a multibeam laser processing head belonging to the device from fig. 1 with a row of fiber exits;

fig. 3 shows a partly sectioned view of a fiber exit mount belonging to the laser processing head, corresponding to the view of fig. 2;

fig. 4 shows a partly sectioned view of the fiber exit mount belonging to the laser processing head along the line IV-IV in fig. 3;

fig. 5 shows a partly sectioned, enlarged and simplified view of a fiber exit and of the beam path in its vicinity;

fig. 6 shows a perspective view of a linear AOM array used for the modulation of the laser beams and for the electronic correction of the position of the image points of the multi-spot array;

fig. 7 shows a very enlarged schematic view of the image points of an ideal linear multi-spot array on the surface of a flexo printing plate clamped on the drum, including a light intensity distribution;

fig. 8 shows a view corresponding to fig. 7, but after the laser processing head and the multi-spot array have been tilted in order to achieve line connection;

fig. 9 shows a very enlarged schematic view of a linear multi-spot array whose image points, as a result of pointing errors of the fiber exits, have been shifted to different extents in arbitrary directions from their intended positions;

fig. 10 shows a view of the multi-spot array from fig. 9 following a rotation of the fiber exits into an angular position in which all the image points have the same angular alignment in relation to their intended positions;

fig. 11 shows a view corresponding to fig. 10, but after the laser processing head and the multi-spot array have been tilted in order to achieve line connection;

fig. 12 shows a view of the multi-spot array from fig. 9 following a rotation of the fiber exits into another angular position, in which all the image points likewise have the same angular alignment in relation to their intended positions;

fig. 13 shows a view corresponding to fig. 12, but after the laser processing head and the multi-spot array have been tilted in order to achieve line connection;

fig. 14 shows a view of the multi-spot array corresponding to fig. 9 following a rotation of the fiber exits corresponding to fig. 10, but as a result of fabrication tolerances of the mount, not all the image points have the same angular alignment in relation to their intended positions.

The device (1) shown in fig. 1 for laser engraving for flexo printing plates substantially comprises a drum (2) which is rotatably clamped between two lateral mounts and on whose circumferential surface the flexo printing plates (3) to be processed are clamped, a rotary drive (not illustrated) for rotating the drum (2) and a printing plate (3) clamped thereon, a carriage (5) which can be moved on guides (4) in the axial direction of the drum (2) and of the printing plate (3), a laser processing head (6) which is mounted on the carriage (5) and which is connected by a bundle of eight fiber optic conductors (7) to a multibeam YAG laser (not visible) in a stationary underpart (8) of the device (1), and also a control desk (9) which can likewise be moved on guides (10) in the axial direction along the drum (2).

As best illustrated in fig. 2, the commercially available flexo printing plate (3) clamped onto the drum (2) for laser engraving substantially comprises, in a known way, a lower carrier layer (11) made of metal or polymer, preferably a polyester film, a photopolymer layer (12) applied to the top of the carrier layer (11) and containing unsaturated monomers and elastomeric binders which are crosslinked to form long-chain polymers when exposed to UVA light, and also a laser-sensitive layer (13) opaque to UV radiation and is applied to the top of the photopolymer layer (12).

During the laser engraving, the flexo printing plate (3) is scanned in accordance with a predefined dot pattern simultaneously by eight laser beams (14) which are focused onto the laser-sensitive layer (13), as illustrated schematically in fig. 2 by two of the laser beams (14). In the process, the laser-sensitive layer (13) is removed by ablation at the points of incidence (15) of the laser beams (14) which are intended to transfer printing ink during the subsequent printing operation, while they are maintained in the remaining areas. The ablation is a thermal process, in which the laser-sensitive layer (13) evaporates down as far as the photopolymer layer (12), forming dot-like openings, and is removed as a result. During subsequent irradiation with UV light, the photopolymer layer (12) cures under the openings and, as opposed to the remaining areas, is not washed out during the subsequent development. The wavelength of the laser radiation emitted by the YAG lasers lies in the infrared range, while the photopolymer is sensitive in the UV range, so that it is not influenced by the laser light during the scanning with the laser beams (14). The scanning of the flexo printing plate (3) is carried out in a predefined dot pattern,

which is produced in the form of digital pixel data by a raster image processor (not illustrated) from the text or image information to be transferred to the printing plate (3).

The 8-channel laser processing head (6) moved in the axial direction (P) of the drum (2) along the printing plate (3) substantially comprises a mount (18) for the fiber exits (19) of the eight fiber optic conductors (7), a linear AOM array (20) for modulating the intensity of the individual laser beams (14), and also of an f-θ optical system (22) which comprises three lenses (L1, L2 and L3) with which the fiber exits (19) are imaged telecentrically as a linear multi-spot array on the surface of the printing plate (3).

As best illustrated in figs. 3 and 4, the fiber exits (19) are inserted with an angular spacing of about 10 mrad beside one another in a fan shape into V-shaped holding grooves (23) in the mount (18), so that the optical axes (24), lying in one plane (E), of the laser beams (14) emerging from the fiber exits (19), after passing through the AOM array (20), intercept at an entry pupil (EP) of the optical system (22), as illustrated schematically in fig. 2 with larger angular spacings, when they have been deflected into the 1st order in the AOMs (21) of the AOM array (20) in order to image the fiber exits (19) on the printing plate (3).

The mount (18), mounted in a cylindrical mounting tube (27) of the laser processing head (6) on a carrier (28) has a rear fixing part (29), facing away from the drum (2), for the fiber exits (19), in which part the latter are clamped for strain relief and also a front holding part (30), facing the drum (2), in which each of the fiber exits (19) is pressed downward

into the associated holding groove (23) by a spring-loaded plunger (31).

As best illustrated in fig. 5, the fiber exits (19) substantially comprise a cylindrical capillary tube (26), into whose one end the end of one of the fiber optic conductors (7) is inserted and its other end serves as a mount for a collimator or micro lens (25), which focuses the laser beams emerging from the fiber exit (19). The focal length f of the micro lens (25) is between f = 3 mm and f = 7 mm, depending on the numerical aperture of the fiber optic conductor. The beam diameter d of the laser beam (14) emerging from the micro lens (25) changes from a diameter d_1 of about 850 μm directly behind the micro lens (25) to a waist diameter d_0 of about 700 μm at $1/e^2$ and, after that, increases again, with a divergence angle $\theta = 2\lambda/\pi\ d_0$, from about 1 mrad at a beam diameter of d_0 = 700 μm, as illustrated by the curved marginal beams.

As best illustrated in fig. 6, the AOM array (20) arranged in the region of the laser beam fan in each case has one AOM (21) for each laser beam (14). In terms of their construction, the AOMs (21) correspond to known acousto-optical modulators and comprise a crystal (32) that is transparent to the laser beam (14) and a piezoelectric converter (33) (only partly shown), which emits ultrasonic waves into the crystal (32) when a voltage signal is applied to the converter (33). As it passes through the crystal (32), the laser beam (14) is diffracted at the ultrasonic waves produced by the converter (33), either, depending on the respective amplitude of the voltage signal, being deflected as a light beam of first order toward the entry pupil (EP) of the optical system (22) and from there to the flexo printing plate (3) or being masked out as a light beam of the 0 order, depending on whether the laser-sensitive

layer (13) of the printing plate (3) is to be removed at the appropriate point or not. The amplitude of the voltage signal is controlled on the basis of the pixel data.

The AOM array (20) is arranged at a point in the beam path of the laser beams (14) at which the intervals between the individual AOMs (21) correspond to the intervals between the associated laser beams (41), and is aligned in such a way that the laser beams (14) in each case enter an optical entry surface of the AOMs approximately at the Bragg angle. In order to improve the diffraction efficiency of the AOMs (21) and to lead the laser beams (14) through the AOMs (21) as far as possible without vignetting, the converters (33) on the individual AOMs (21) are in each case aligned in parallel with the optical axis (24) of the laser beam (14) passing through.

The AOM array (20) and the entry pupil (EP) of the optical system (22) are each at such a distance from the waist T of the laser beams (14) (fig. 5) that both the AOMs (21) and the entry pupil (EP) lie within the Rayleigh distance, within which the diameter of the laser beam (14) increases to $d_0 \times \sqrt{2}$.

Ideally, the laser beams (14) emerging from the micro lenses (25) of the fiber exits (19) are parallel to the respective cylinder axes of the capillary tubes (26), and the holding grooves (23) have the same angular spacings and heights, as a result of which the fiber exits (19) are theoretically imaged on the printing plate (3) as an ideal multi-spot array, whose image points all lie on one axis (X) and are at the same intervals, as illustrated in fig. 7. Given an angular spacing of the fiber exits (19) of 10 mrad and a spacing/diameter ratio of 8 to 1 in the mount (18), the result for the points of incidence (15) of the eight laser beams (14) on the laser-

sensitive layer (13) and therefore for adjacent image points of the linear multi-spot array is center spacings lx of about 160 μm and spot diameters d(50%) of about 20 μm.

In practice, however, the multi-spot array is only seldom ideal, firstly, because the laser beams (14) emerging from the micro lenses (25), because of so-called pointing errors of the fiber exits (19), exhibit more or less large angular deviations from the cylinder axis of the capillary tube (26), and secondly because the holding grooves (23) belonging to the mount (18), on account of fabrication tolerances, are not always arranged equidistantly and at the same height. As a result of the pointing errors, at least some of the image points of the multi-spot array exhibit deviations from the intended position on the printing plate, as illustrated somewhat exaggeratedly in fig. 9, commonly both the distances between the image points and their intended positions (illustrated as white circles) and the directions or angular directions of the image points in relation to their intended positions being different.

In order to correct these deviations from the respective intended position, according to the invention, firstly all the fiber exits (19) are inserted mechanically into the holding grooves (23) in such a way that all the image points of the multi-spot arrays have substantially the same angular alignment in relation to their intended position, as illustrated in Figs. 10 and 12 by using two examples, before the distances of the individual image points from their intended position, if necessary, is then reduced electronically by means of appropriate deflection of the laser beams (14) in the AOMs (21) and/or by means of appropriate delay of the points of incidence of the laser beams (14) on

the printing plate (3). The two electronic correction steps can in each case be carried out individually or alternately one after the other, until the distances are reduced to zero or virtually zero.

Here, the same angular alignment means that the direction vectors from the respective intended position to the respective image point exhibit the same angle (γ) with the axis (X) running through all the intended positions and, preferably, the same sign. If the angular errors of the laser beams (14) are relatively small and the bandwidth of the AOMs (21) is sufficient in order to correct the errors substantially by means of deflecting the laser beams (14) in the AOM (21), the angles (γ) are preferably selected such that, as in the multi-spot array illustrated in fig. 10, they are all 90°. If the angular errors are greater, so that the bandwidth of the AOMs (21) available for the correction is inadequate, the angles (γ) are preferably selected such that, as in the multi-spot array illustrated in fig. 12, they are in each case 7.13° (corresponding to 90° - arctan lx/d(50%)), so that the deviations from the intended position can substantially be corrected by means of an appropriately adapted time delay of the voltage signals.

A substantially coincident angular alignment of all the image points is achieved if the fiber exits (19) in each case are inserted into the holding grooves (23) in the mount (18) with such a rotational position in relation to the cylinder axis of their capillary tubes (26) that the pointing errors of all the fiber exits (19) point in the same direction. The rotational position of each fiber exit (19) required for this purpose is determined, before the latter is mounted in the mount (18) of the laser processing head (6), in an adjusting device (not

illustrated) in which each fiber exit (19) is inserted into a holding groove corresponding to the holding grooves (23) and, with the laser light switched on, is rotated about its axis, while the position of an image point produced on a position detector by the emerging laser beam (14) is recorded. During the rotation of the fiber exit, this image point describes a circular path, whose diameter is greater the greater the pointing error of the fiber exit (19). Every time the image points exhibit a desired angular alignment in relation to the axis or in relation to a corresponding coordinate system belonging to the adjusting device, for example lie vertically above the axis, a marking is applied to the fiber exit (19), which corresponds to this angular alignment and, for example, likewise points upward. Following the determination of the pointing errors of all the fiber exits (19), the latter are inserted into the holding grooves (23) in the mount (18) in such a way that all the markings point in the same direction, for example upward again.

Instead of being provided with markings, the fiber exits (19) illustrated in fig. 4 are in each case provided with a flag (35) which projects radially beyond the capillary tube (26) and which indicates the direction of the pointing error of the fiber exit (19) or a defined angular distance from said error. The flag (35) is part of a rotatable cylindrical bush (36) which is pushed onto the capillary tube (26) and which, in the adjusting device, is firmly adhesively bonded on the capillary tube (26) in accordance with the direction of the pointing error. At its upper end, the flag (35) has an alignment notch (not visible), in which an alignment pin (37) which is inserted into the mount (18) in a fixed position, above the fiber exit (19), and is parallel to the respective holding groove (23), engages. This measure not only ensures that the

fiber exits (19) are inserted into the holding grooves (23) in the previously defined rotational position, but also prevents subsequent rotation of the fiber exits (19) about their axis.

In order to achieve line connection, that is to say to reduce the center spacings lx between two adjacent image points in the axial direction (P) of the drum (2) to such an extent that the two points (15) overlap at 50% of the maximum intensity, that is to say at d(50%), the plane (E) covered by the converging laser beams (14) after the fiber exits (19) have been inserted into the holding grooves (23) are tilted about the axis (A), by rotating the entire laser processing head (6), out of the position in relation to the axis (P) illustrated in fig. 2, so that the multi-spot array is aligned at an angle α = arctan lx/d(50%) = arctan 8/1 = 82.87° with respect to the drum feed direction (P) or at an angle 90°-α with respect to the drum circumferential direction (R), as illustrated in Figs. 11 and 13. In addition, the individual AOMs (21) of the AOM array (20) have the voltage signals applied to them with an appropriate time delay, depending on the rotational speed of the drum (2), so that the eight laser beams (14) strike the laser-sensitive layer (13) on the printing plate (3) simultaneously beside one another in the drum feed direction (P).

In order to correct the deviations of the image points from their intended positions, in the multi-spot array illustrated in fig. 11, the laser beams (14) are additionally deflected, by changing the frequency of the voltage signals supplied to the AOMs (21) in a direction perpendicular to the axis (X) (indicated by small arrows) to such an extent that the image points previously rotated in this direction (cf. fig. 11) come to lie on the axis (X).

By contrast, in the multi-spot array illustrated in fig. 13, the correction of the deviations of the image points from their intended positions is carried out by means of a different time delay in the drum circum-ferential direction (R) (indicated by small arrows), this time delay being set for each laser beam (14) in such a way that the associated image point comes to lie on the axis (X).

If the angular alignment of one or more image points changes following the insertion of the fiber exits (19) into the holding grooves (23), because of fabrication tolerances during the production of the mount (18), as illustrated in fig. 14 using the example of the two image points on the furthest right, the aforementioned correction steps (deflection or propagation-time delay) are carried out iteratively until the image points assume their intended positions.

The electronic correction is carried out with the aid of test images which, in each case after a correction step has been carried out, are created with the aid of a test printing plate that is clamped onto the drum, the correction being carried out step by step until no disruptive patterns are visible on the test images. Alternatively, before the exposure of the first test printing plate, a correction can be made in which the pointing errors measured in the adjusting device are compensated for, in terms of magnitude, by means of an appropriate deflection and/or time delay of the respective laser beam.

Claims

1. A multibeam scanning device for scanning a photo-sensitive material with a multi-spot array, in particular for the laser exposure of film or for the laser engraving of printing plates, comprising a mount, which has a plurality of holders for one fiber laser fiber exit in each case, a plurality of fiber exits inserted detachably into the holders, and devices for interrupting, deflecting and/or modulating the intensity of laser beams emerging from the fiber exits, characterized in that the mount (18) and the fiber exits (19) are provided with complementary alignment devices (35, 36), which in each case come to coincide or enter into mutual engagement when a fiber exit (19) in the holder (23) has a previously defined rotational angle in relation to its axis, all the image points of a multi-spot array produced on the photosensitive material (3) by imaging the fiber exits (19) have substantially the same angular alignment in relation to their intended position as soon as the alignment devices (35) of all the fiber exits (19) coincide with the complementary alignment devices (36) on the mount (18) or are engaged.

2. The multibeam scanning device as claimed in claim 1, characterized by correction devices for displacing individual image points of the multi-spot array by means of electronic deflection of the laser beams (14) in a direction (Y) which is perpendicular to an axis (X) through the intended positions of the image points.

3. The multibeam scanning device as claimed in claim 1 or 2, characterized by correction devices for displacing individual image points of the multi-spot array by means of electronic delay of the point of incidence of the laser beams (14) on the

photosensitive material (3) in a direction (R) which is parallel to the direction of a relative movement between the multibeam scanning device (6) and the photosensitive material (3).

4. The multibeam scanning device as claimed in one of claims 1 to 3, characterized in that the devices for interrupting, deflecting and/or modulating the intensity of the laser beams (14) emerging from the fiber exits (19) comprise a plurality of acousto-optical modulators (21) between the fiber exits (19) and the photosensitive material (3).

5. The multibeam scanning device as claimed in claim 4, characterized in that the acousto-optical modulators (21) are used as correction devices for displacing individual image points of the multi-spot array by means of deflecting the laser beams (14) and/or delaying the point of incidence of the laser beams (14) on the photosensitive material (3).

6. The multibeam scanning device as claimed in one of claims 1 to 5, characterized in that the laser beams (14) form a converging fan of beams.

7. The multibeam scanning device as claimed in one of claims 1 to 6, characterized by an f-θ optical system (22) for imaging the fiber exits (19) telecentrically on the photosensitive material (3).

8. The multibeam scanning device as claimed in one of claims 1 to 7, characterized in that the alignment devices of the fiber exits (19) each comprise a radially projecting element (35).

9. The multibeam scanning device as claimed in claim 8, characterized in that the element (35) projects beyond a bush (34), which surrounds a capillary tube (26) arranged between a fiber optic conductor (7) and a collimator lens (25) belonging to the fiber exit (19) and is fixed to said capillary tube (26).

10. The multibeam scanning device as claimed in one of claims 1 to 7, characterized in that the alignment devices comprise markings on the fiber exits (19) and on the mount (18), which may be aligned in relation to each other by rotating the fiber exits (19) in the holders (23).

11. A device for exposing or processing a photosensi-tive material with laser beams, in particular for the laser exposure of film or for laser engraving of printing plates with a multi-spot array, characterized by a multibeam scanning device (6) as claimed in one of claims 1 to 10.

12. A method for correcting the position of image points of a multi-spot array, which is produced by imaging a plurality of fiber laser fiber exits of a multibeam scanning device on a photosensitive material that is moved in relation to the multibeam scanning device and by interrupting, deflecting and/or modulating the intensity of laser beams emerging from the fiber exits, characterized in that the fiber exits (19) are in each case inserted into a holder (23) of a mount (18) of the multibeam scanning device (6) at a previously defined rotational angle in relation to their longitudinal axis, so that all the image points have substantially the same angular alignment in relation to their intended position, and in that the distances of the individual image points from their intended positions, if necessary, are subsequently reduced by

deflecting the laser beams (14) and/or by delaying the point of incidence of the laser beams (14) on the photosensitive material (3).

13. The method as claimed in claim 12, characterized in that the distances between the individual image points are reduced until each image point lies at its intended position.

14. The method as claimed in claim 12 or 13, characterized in that the deflection of the laser beams (14) and the delaying of the point of incidence of the laser beams (14) are performed alternately in order to bring the image points step by step to the intended position.

15. The method as claimed in one of claims 12 to 14, characterized in that in order to reduce the distance, the laser beams (14) are deflected in such a way that individual image points of the multi-spot array are shifted in a direction (Y) which is perpendicular to an axis (X) through the intended positions of the image points.

16. The method as claimed in one of claims 12 to 15, characterized in that in order to reduce the distance, the point of incidence of the laser beams (14) on the photosensitive material (3) is delayed in a direction (R) which is parallel to the direction of the relative movement between the multibeam scanning device (6) and the photo-sensitive material (3).

17. The method as claimed in one of claims 12 to 16, characterized in that the interruption, deflection and/or intensity modulation of each laser beam (14), after it emerges

from the fiber exit (19), is performed in an acousto-optical modulator (21).

18. The method as claimed in claim 17, characterized in that the point of incidence of each laser beam (14) on the photosensitive material (3) is delayed by means of time control, which takes account of the distance of the image point from the intended position, of the supply of voltage signals to the acousto-optical modulator (21).

19. The method as claimed in claims 17 or 18, characterized in that in order to deflect each laser beam (14), the frequency is changed of a voltage signal which is applied to the acousto-optical modulator (21) in order to interrupt, deflect and/or modulate the intensity of the laser beam (14).

20. The method as claimed in one of claims 12 to 19, characterized in that each fiber exit (19), before being inserted into the holder (23) of the mount (18), is rotated about its axis in an adjustment device until an image point produced by the fiber exit (19) has a predefined angular alignment in relation to the axis of rotation, and in that each fiber exit (19) at this rotational position is provided with an alignment device (35) which, when inserted into the holder (23) of the mount (18), is aligned with or brought into engagement with a complementary alignment device (36) belonging to the mount.

Abstract

The invention relates to a multibeam scanning device (6) for scanning a photosensitive material (3) with a multi-spot array, comprising a plurality of fiber laser fiber exits (19), which are in each case inserted detachably into a holder (23) of a mount (18) of the multibeam scanning device (6). The invention further relates to a method for correcting the position of image points of a multi-spot array, which is produced by imaging a plurality of fiber laser fiber exits (19) of a multibeam scanning device (6) on a photosensitive material (3) that is moved in relation to the multibeam scanning device (6) and by interrupting, deflecting and/or modulating the intensity of laser beams (14) emerging from the fiber exits (19). In order to permit the generation of a very precise multi-spot array, which causes no visible disruptive patterns on the end product when the photosensitive material is used as a printing original, the invention proposes to insert the fiber exits (19) into a holder (23) of a mount (18) of the multibeam scanning device (6) in each case with a previously defined rotational angle in relation to their axis, so that all the image points have substantially the same angular alignment in relation to their intended position, and then to reduce the distances of the individual image points from their intended positions, if necessary, by deflecting the laser beams (14) and/or by delaying the point of incidence of the laser beams (14) on the photosensitive material (3) to zero or virtually zero.

(fig. 4)

/bb

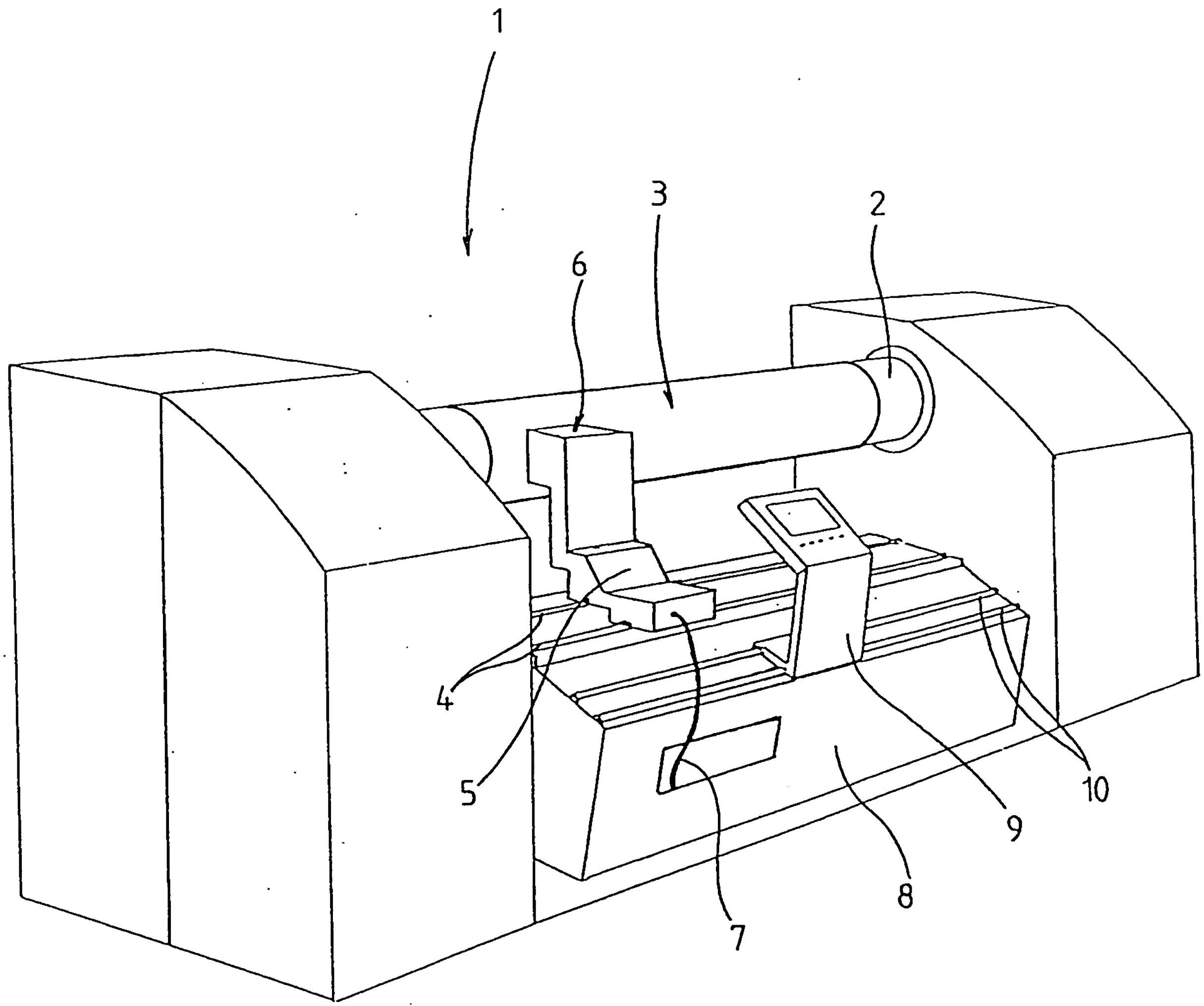

FIG. 1

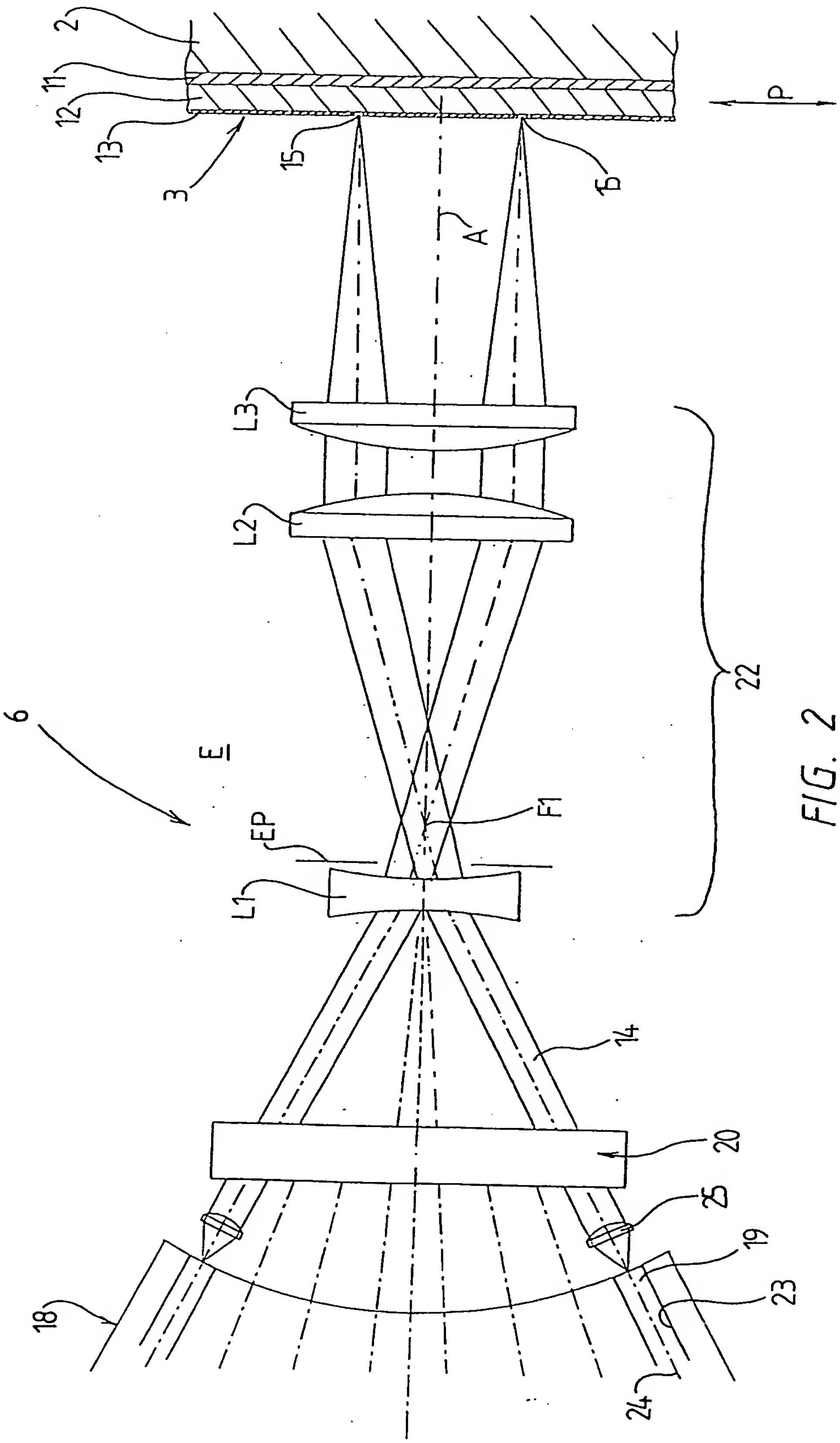

FIG. 2

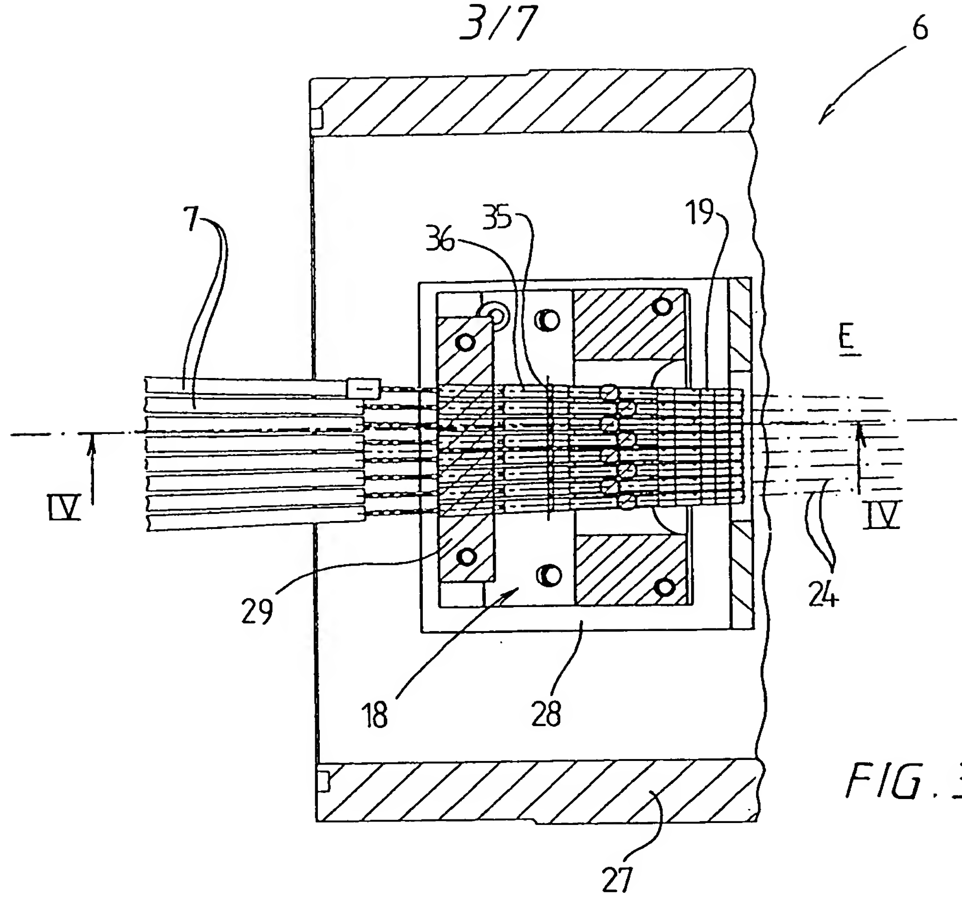

FIG. 3

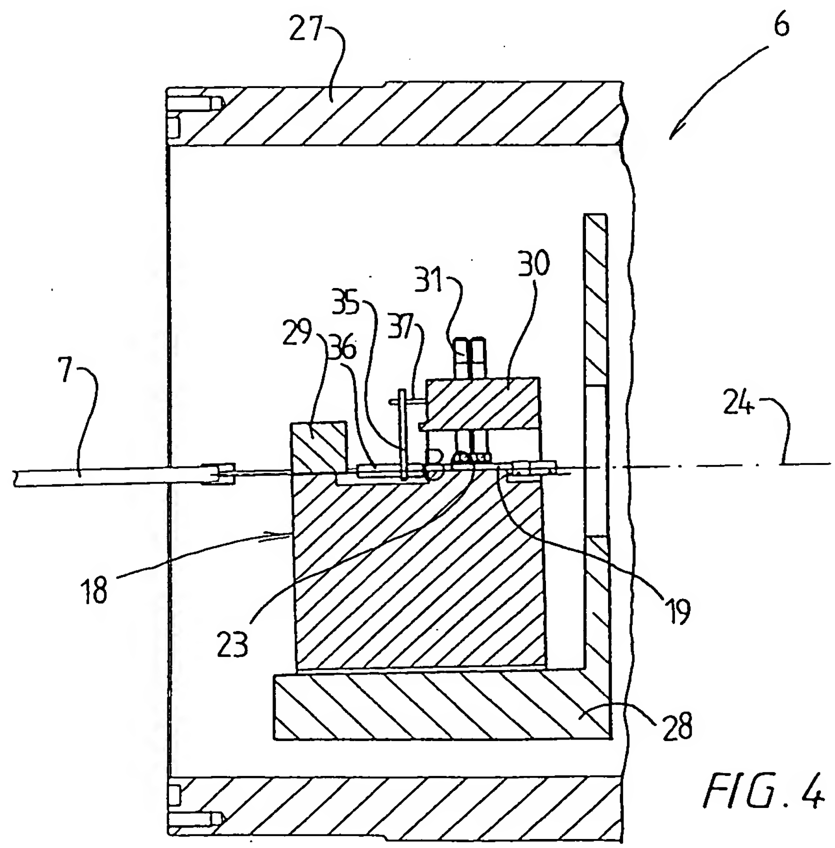

FIG. 4

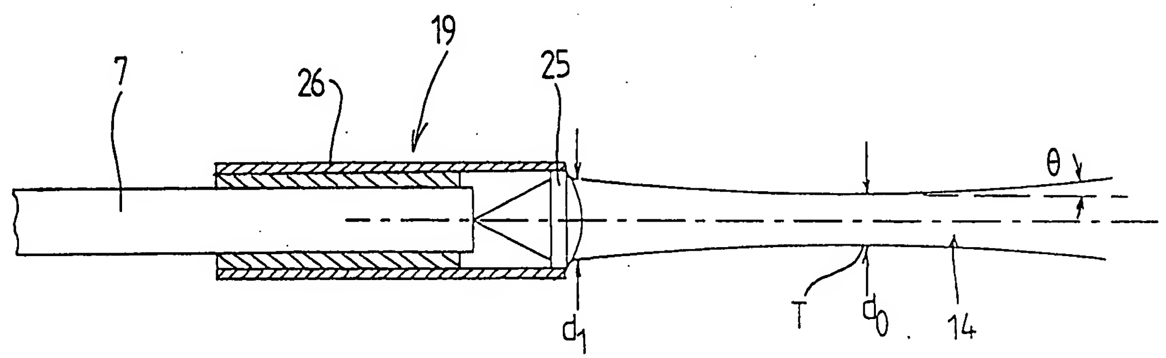

FIG. 5

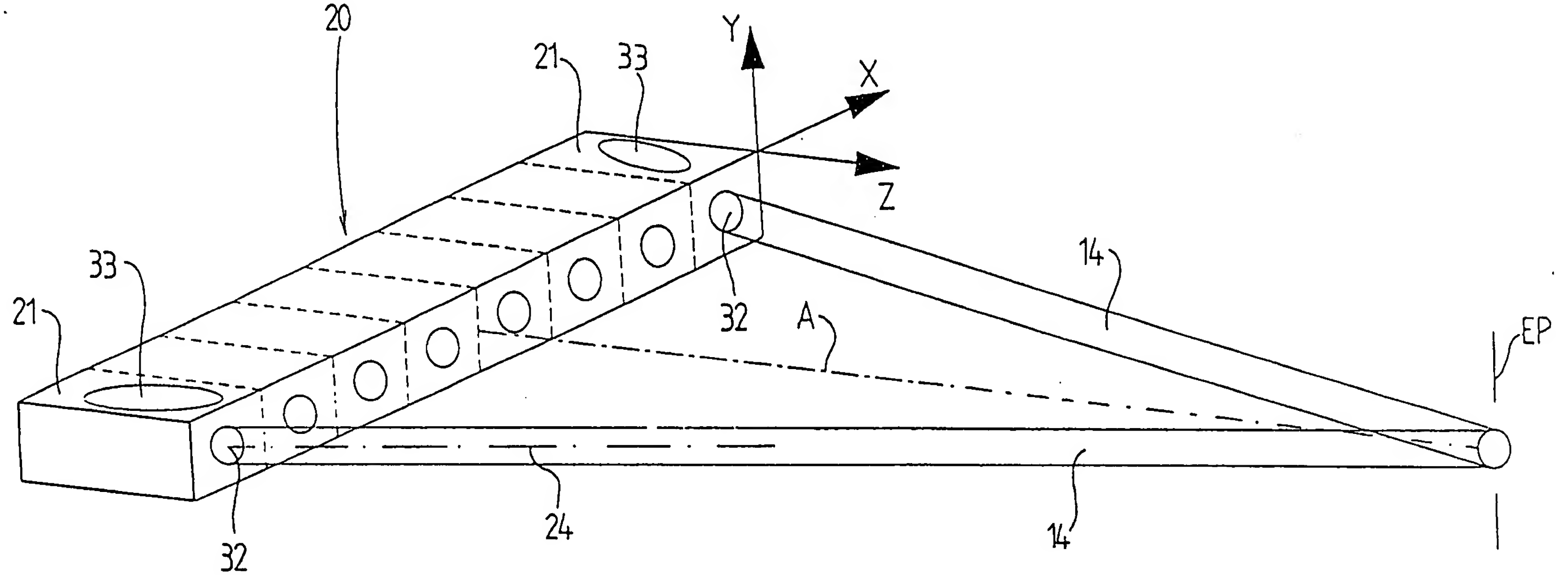

FIG. 6

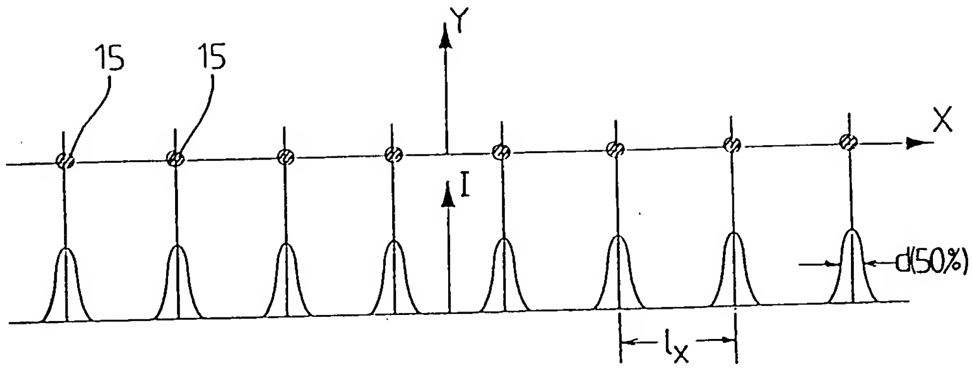

FIG.7

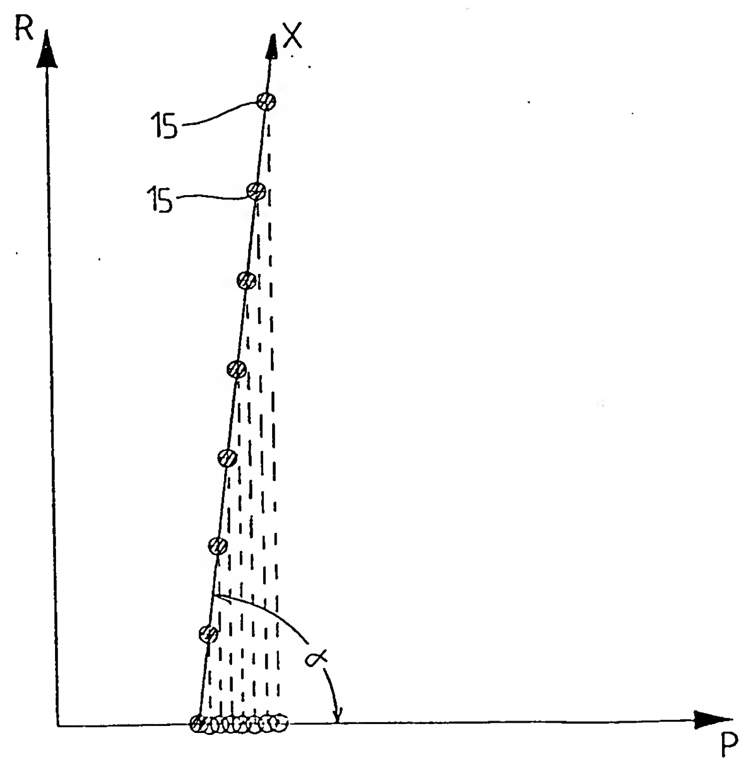

FIG.8

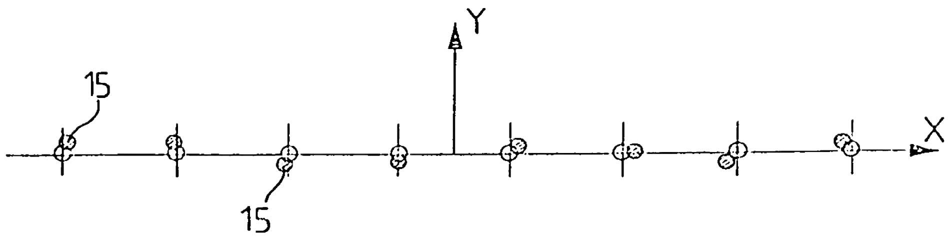

FIG. 9

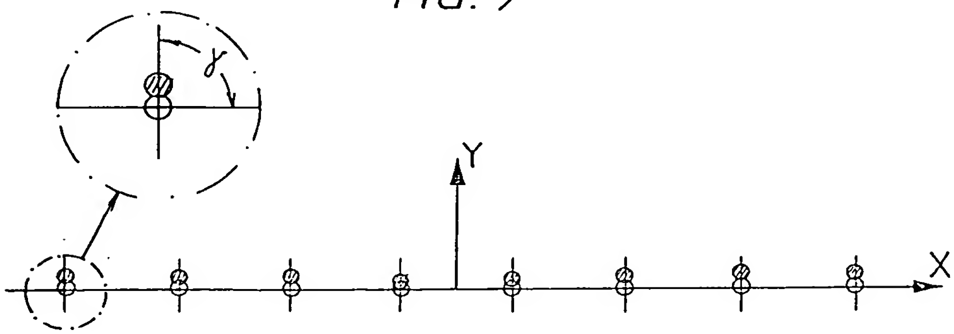

FIG. 10

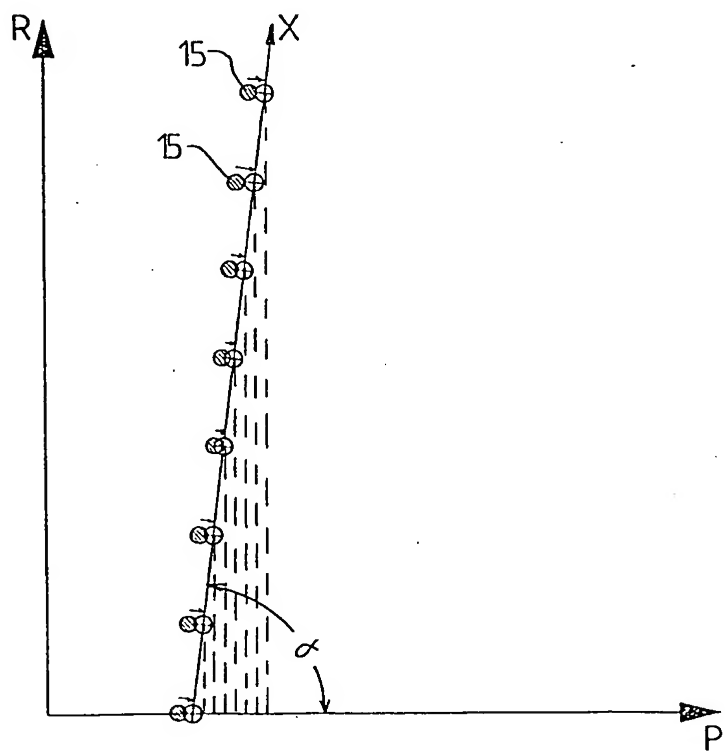

FIG. 11

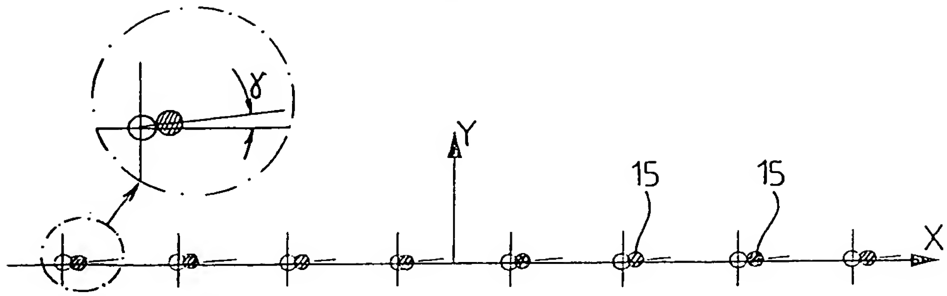

FIG. 12

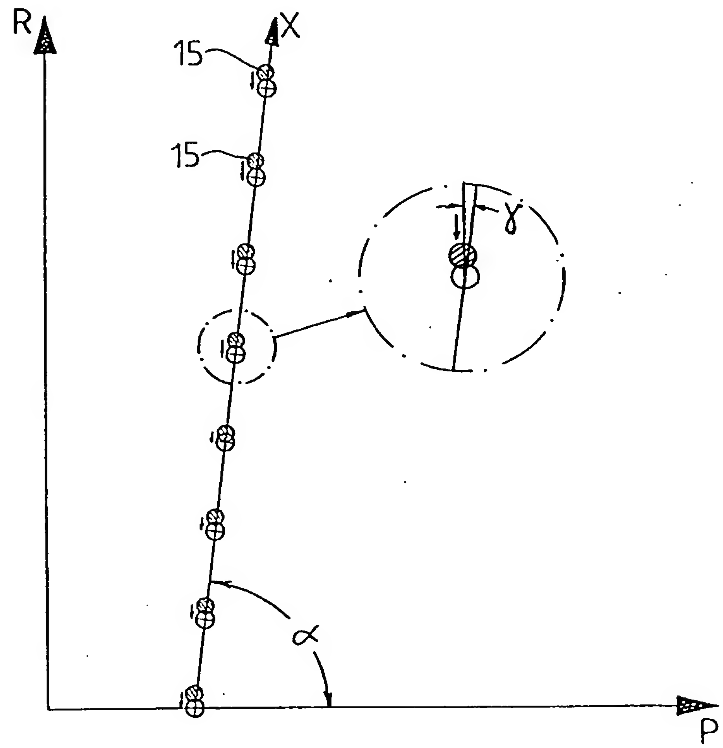

FIG. 13

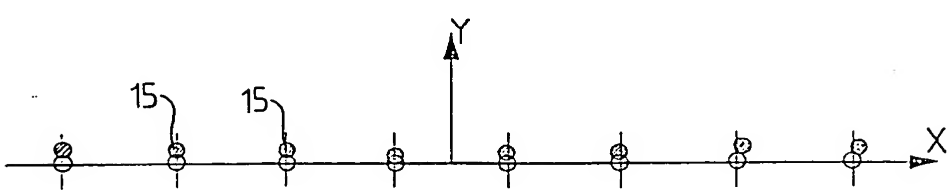

FIG. 14

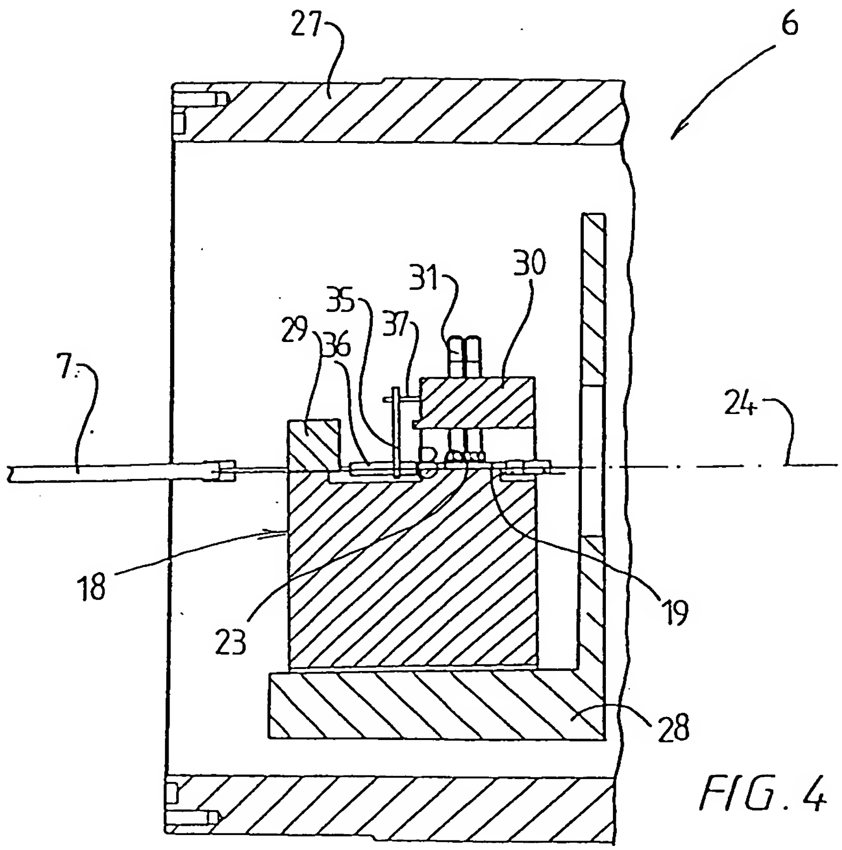

FIG. 4